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23 September 1992

Mr. Wayde Hartwick, HSM-6J
Remedial Project Manager
U.S. Environmental Protection Agency
77 West Jackson Boulevard
Chicago, Illinois 60604

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Re: ISVE Enhancement for Semivolatile Organic Compounds (SVOCs)
and Polychlorinated Biphenyls (PCBs)

Dear Mr. Hartwick:

At your request, Roy F. Weston, Inc. (WESTON) has examined the potential applicability of enhancements to conventional in-situ vapor extraction (ISVE). The purpose of considering the enhancements is that some of the contaminants at the ACS Site are not readily removed by conventional ISVE.

Results

WESTON has identified two promising emerging technologies that use enhancements to conventional ISVE to remove a wider range of organic contaminants. These technologies are known as thermally enhanced ISVE and biologically enhanced ISVE (also known as bioventing). Both enhancements are currently in the preliminary stages of development to assess their usefulness on a wide range of contaminants, so information regarding them is scarce. Even so, we were able to identify a total of seven vendors for the enhanced technologies.



Mr. Wayde Hartwick
U.S. Environmental Protection Agency

-2-

23 September 1992

Thermally Enhanced ISVE

Thermally enhanced ISVE uses electrodes, steam, or hot air to encourage volatilization of recalcitrant organics. All of the vendors claim that their systems remove SVOCs, and one even claims that it can remove PCBs. Information from the VISITT database regarding thermally enhanced ISVE is attached.

Bioventing

Bioventing adds vapor-phase ammonia and phosphorous to the vadose zone, encouraging growth of heterotrophic bacteria which metabolize nonhalogenated organic carbon (including nonhalogenated SVOCs) as a food source. Halogenated SVOCs and PCBs are much less amenable to bioventing as halogenated organics are not aerobically degraded. Most of the vendors of bioventing make indirect reference to ability of their systems to reduce halogenated SVOCs by cometabolism. One vendor claims that its bioventing system can remove PCBs. Information from the VISITT database regarding thermally enhanced ISVE is attached.

Conventional ISVE

To provide a baseline comparison against the enhanced systems, WESTON has also identified several vendors of conventional ISVE that claim they can remove SVOCs. These claims should be viewed cautiously because the physical properties of SVOCs assure that they will be challenging for any ordinary ISVE system. The information from the VISITT database is attached.

Summary

WESTON believes that either bioventing or thermally enhanced ISVE would potentially improve the probability of attaining the treatment objectives for a broad range of organic chemicals at the ACS Site compared to the probability of success with conventional ISVE. Because the technologies are so new and unfamiliar, it is difficult to predict their performance with any certainty. If U.S. EPA would like to investigate these technologies,



Mr. Wayde Hartwick
U.S. Environmental Protection Agency

-3-

23 September 1992

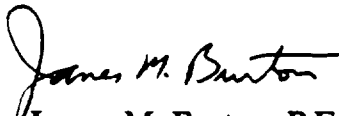
the Remedial Design phase of the project could begin with parallel treatability testing of the various ISVE enhancements at the laboratory scale. The lab-scale testing program would generate the quantitative data needed to select the particular technology with some assurance that it can achieve the required cleanup levels. Alternatively, the results of the investigation of the technologies under ongoing SITE demonstrations can be used to predict the applicability at the ACS Site.

If you have any questions or require additional clarification, please call.

Very truly yours,

ROY F. WESTON, INC.

Robert H. Gilbertsen, P.E.
Project Engineer


James M. Burton, P.E.
Site Manager

Attachments

RHG:JMB/kvh

**VISITT INFORMATION
FOR
CONVENTIONAL ISVE**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 11/14/91

Developer/Vendor name: AWD TECHNOLOGIES

Street address: 15204 Omega Drive
Suite 200

City: Rockville State: MD Zip: 20850

Country: USA

Contact name: Mr. Robert Kleinsteuber

and title...: Manager, Marketing Communications

Contact phone: (301) 948-0040 Fax Number: (301) 948-6094

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION

Technology name assigned by vendor (e.g., trade name):

AquaDetox/VES

Technology is being or has been tested in EPA SITE Program ? Yes

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

General description of technology:

The integrated AquaDetox/VES continuous system developed and patented by AWD Technologies, Inc. simultaneously treats groundwater and soil contaminated with VOCs. This technology integrates two basic processes: (1) a high-efficiency, moderate vacuum stripping tower (tower pressure no less than 50 mm HG) that uses low-pressure steam to treat contaminated groundwater and (2) a vapor extraction system (VES) that removes contaminated soil for subsequent treatment with granular activated carbon (GAC).

Integrating the two technologies creates a closed-loop system, providing simultaneous remediation of contaminated groundwater and soil with virtually no air emissions. By carefully engineering the VES extraction pressures and introducing phase transfer elements as needed, the contamination extracted by the VES can be transferred to the AquaDetox system, where it is ultimately recovered in recyclable liquid form. This eliminates many significant air quality permitting requirements. Both groundwater and soil remediation are performed simultaneously with no discharge to the atmosphere or sewer. Also, there is no contaminated GAC to require disposal since the carbon beds are regenerated with steam, and the contaminated steam is injected into the AquaDetox unit.

Part 1: General Information and Technology Overview (continued)

Vendor name....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Technology highlights:

Integrated system addressing both contaminated soil and water. Lower contaminant discharges of effluent and air due to high efficiency stripping and on-site absorption regeneration.

In-house data base of more than 90 of the 100+ priority pollutants with research capability to provide necessary data for process design without the usual pilot testing program.

High-tech engineering capabilities, including process simulation of electrolytes and their effect on metallurgy and operability.

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Part 1: General Information and Technology Overview (continued)

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- ☒ Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- ☒ Soil
- Sludge
- Solid
- Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input checked="" type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

General sources or types of industrial waste or contaminated sites
that the technology can address:

- | | |
|---|--|
| <input checked="" type="checkbox"/> Agriculture | <input checked="" type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input type="checkbox"/> Coal gasification | <input type="checkbox"/> Photographic products |
| <input checked="" type="checkbox"/> Dry cleaners | <input type="checkbox"/> Plastics manufacturing |
| <input type="checkbox"/> Electroplating | <input type="checkbox"/> Pulp and paper industry |
| <input checked="" type="checkbox"/> Herbicide manufacturing/use | <input checked="" type="checkbox"/> Other organic chemical manufacturing |
| <input checked="" type="checkbox"/> Industrial landfills | <input type="checkbox"/> Other inorganic chemical manufacturing |
| <input type="checkbox"/> Inorganic/organic pigments | <input checked="" type="checkbox"/> Semiconductor manufacturing |
| <input type="checkbox"/> Machine shops | <input checked="" type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input checked="" type="checkbox"/> Wood preserving |
| <input checked="" type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input type="checkbox"/> Munitions Manufacturing | |

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Technology limitations:

VES:

Soil stratigraphy and water table are key components to an effective soil vapor extraction system. Therefore, if the water table is very close to the surface or the soil has little porosity, the effectiveness of the system will be greatly reduced.

STEAM STRIPPING:

Solubility of contaminant in the water is one of the most important factors in consideration of this technology. While organic compounds with solubilities in the present range are feasible, removal by free phase separation is adversely affected.

Use of steam requires utility water be available for generation of boiler feed water. If potential site does not afford such, it is not applicable.

Certain natural occurring conditions may exist with the water in question to make use of this technology impractical without treatment of the aquifer prior to stripping.

Some 90 compounds of the EPA Priority Pollutant List have been identified as potential candidates for steam stripping and some of which are known to have boiling points greater than 200 degrees C. There are no physical minimum contaminant limitations of the technology. Maximum limits are for the most part, the solubility limit of the contaminant in water. For some contaminants, test results have shown high efficiency removals can still be achieved with free phase product occurring in the water.

Technology status comments:

The integrated technology has been operated successfully for over three years. Independent systems have been installed and operated over many more years. As AWD's parent company, Dow was the inventor of part of this technology, and many years of experience through some 45 operating units within the Dow Chemical Company have developed a significant database and operating discipline for application of the technology.

Significant improvements have occurred within the process design of the stripping technology through greater understanding of inorganic contaminants and their impact upon the operation of the system.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Vendor services:

- ☒ Equipment manufacture
- ☒ Subcontractor for cleanup services
- ☒ Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

The pilot system consists of a vacuum pump and tank. Wells, piping, and emissions control, if required, are field adapted.

The integrated AquaDetox/VES continuous system developed and patented by AWD Technologies, Inc. simultaneously treats groundwater and soil contaminated with VOCs. This technology integrates two basic processes: (1) a high-efficiency, moderate vacuum stripping tower (tower pressure no less than 50 mm Hg) that uses low-pressure steam to treat contaminated groundwater and (2) a vapor extraction system (VES) that removes contaminated soil for subsequent treatment with granular activated carbon (GAC).

Integrating the two technologies creates a closed-loop system, providing simultaneous remediation of contaminated groundwater and soil with virtually no air emissions. By carefully engineering the VES extraction pressures and introducing phase transfer elements as needed, the contamination extracted by the VES can be transferred to the AquaDetox system, where it is ultimately recovered in recyclable liquid form. This eliminates many significant air quality permitting requirements. Both groundwater and soil remediation are performed simultaneously with no discharge to the atmosphere or sewer. Also, there is no contaminated GAC to require disposal since the carbon beds are regenerated with steam, and the contaminated steam is injected into the AquaDetox unit.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Number of pilot-scale systems:

1 Planned/in design
 Under construction
1 Constructed

Pilot-scale facility is:

☒ Transportable
☐ Fixed
☐ In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

 to

Can you conduct pilot-scale treatability studies on some type of waste
at your location? Yes

At a contaminated site? Yes

Quantity of waste needed for pilot-scale treatability study:

 to

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Full-scale Equipment/Capabilities

Major unit processes:

The system uses extraction and injection wells in the vadose zone. Carbon beds remove the organics. On site regeneration is achieved using steam. The regeneration steam is condensed and sent to the vacuum steam stripper for final cleanup. The carbon is still functioning well after three years. We anticipate a minimum life of five years with ten years as most probable.

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Full-scale facility is:

☐ Transportable ☒ Fixed ☐ In situ

Location of fixed facility :

City: _____ State: _____

Full capacity range per hour:

600.00 to 1000.00 Gal/hour

Logistical requirements for transportable or in situ technologies:

Space (area).....: 100 ft²

Water: _____ gals. per day

Electrical power: 75 amps

110 volts

Natural gas.....: _____ ft³ per day

Sewage access....: ☐ yes ☒ no

"Ballpark" estimate of price range per unit of waste treated:

20.00 to 50.00 per Cubic yard

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Factors that have significant effect on unit price (1 is highest):

<u>5</u>	Initial contaminant concentration	<u> </u>	Excavation
<u>5</u>	Target contaminant concentration	<u> </u>	Waste handling
<u>5</u>	Waste quantity	<u> 2</u>	Permitting
<u>5</u>	Depth of contamination	<u> </u>	Pretreatment
<u>3</u>	Depth to ground water	<u> </u>	Amount of debris
<u>5</u>	Residual quantity	<u> 8</u>	Utility/fuel rates
<u>1</u>	Residual waste characteristics	<u> 7</u>	Labor rates
<u>6</u>	Site preparation		

Others:

4 Soil permeability

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**PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)**

Vendor name.....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Number of full-scale cleanups initiated or completed by this firm using this technology:

1

For equipment manufacturers - estimated or actual number of full-scale cleanups by other firms using this equipment:

Major permits obtained for a full-scale system, and issuing authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: Bldg. Permit South Coast Water Dist. NPDES
 Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

1 Planned/in design

Under construction

Constructed

Detailed Information and Performance Data (continued)

Vendor name....: AWD TECHNOLOGIES

Technology type: SOIL VAPOR EXTRACTION

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

Description of bench-scale testing procedures:

Not practical.

[illegible]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 09/28/91

Developer/Vendor name: OHM CORPORATION

Street address: 2950 Buskirk Ave., Suite 315

City: Walnut Creek State: CA Zip: 94596

Country: USA

Contact name: Robert Cox

and title...: Director, In Situ Remediation

Contact phone: (510) 256-7187 Fax Number: (510) 256-4286

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? No

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

General description of technology:

In situ soil vapor extraction involves extraction of air containing volatile chemicals from unsaturated soil. IN OHM's patented process (U.S. Patent No. 4,435,292), clean air is injected or flows into the subsurface at locations around a spill site, and the vapor-laden air is withdrawn under vacuum from recovery or extraction vents. A typical system consists of:

- (1) one or more extraction vents,
- (2) one or more air inlet or injection vents (optional),
- (3) piping or air headers,
- (4) vacuum pumps and/or air blowers,
- (5) flow meters and controllers,
- (6) vacuum gauges,
- (7) sampling ports,
- (8) air/water separator, and
- (9) vapor treatment system.

OHM also uses soil pile vapor extraction technology to treat contaminated soil ex situ. The soil pile vapor extraction process is the same as the in situ process described above with the exception that the contaminated soil is excavated from the site. The excavated material is placed in a pile containing the air injection and extraction piping. The soil pile is covered with a plastic membrane to prevent volatile emissions.

Off gas treatment varies depending on the concentration and type of contaminant. Treatment includes activated carbon, thermal destruction, catalytic oxidation, and UV light.

Part 1: General Information and Technology Overview (continued)

Vendor name....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Technology highlights:

Soil vapor extraction is a cost-effective technique for the removal of volatile organic chemicals (VOCs) from contaminated soils. Soil vapor extraction processes cause minimal disturbance of the contaminated soil and can be constructed from standard equipment. The technology has been demonstrated at both pilot- and field-scale levels. The process can be used to treat large volumes of soil that would be prohibitively expensive to excavate, and there is a potential for the recovery of the volatile material.

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Part 1: General Information and Technology Overview (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- X Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- X Soil
- Sludge
- X Solid
- Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Petroleum Hydrocarbons (gasoline,diesel)

Part 1: General Information and Technology Overview (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

General sources or types of industrial waste or contaminated sites
that the technology can address:

<input checked="" type="checkbox"/> Agriculture	<input type="checkbox"/> Paint/ink formulation
<input type="checkbox"/> Battery recycling/disposal	<input checked="" type="checkbox"/> Pesticide manufacturing/use
<input type="checkbox"/> Chloro-alkali manufacturing	<input type="checkbox"/> Petroleum refining and reuse
<input type="checkbox"/> Coal gasification	<input type="checkbox"/> Photographic products
<input checked="" type="checkbox"/> Dry cleaners	<input checked="" type="checkbox"/> Plastics manufacturing
<input type="checkbox"/> Electroplating	<input checked="" type="checkbox"/> Pulp and paper industry
<input checked="" type="checkbox"/> Herbicide manufacturing/use	<input checked="" type="checkbox"/> Other organic chemical manufacturing
<input checked="" type="checkbox"/> Industrial landfills	<input type="checkbox"/> Other inorganic chemical manufacturing
<input type="checkbox"/> Inorganic/organic pigments	<input checked="" type="checkbox"/> Semiconductor manufacturing
<input checked="" type="checkbox"/> Machine shops	<input type="checkbox"/> Rubber manufacturing
<input checked="" type="checkbox"/> Metal ore mining and smelting	<input type="checkbox"/> Wood preserving
<input checked="" type="checkbox"/> Municipal Landfill	<input type="checkbox"/> Uranium mining
<input type="checkbox"/> Munitions Manufacturing	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Technology limitations:

This technology is not applicable to nonvolatile compounds, lubrication oils, heavy ends products from petroleum processing, and aliphatic carbon compounds with greater than 25 carbon atoms.

The soil characteristics at a site have a significant effect on the applicability of vapor extraction systems. Air conductivity controls the rate at which air can be drawn from soil by the applied vacuum. Grain size, moisture content, soil aggregation, and stratification are the most important properties. The soil moisture content is also important since it is easier to draw air through drier soils. As the size of a soil aggregate decreases, the time required for diffusion of the chemical out of the immobile regions also increases. However, even clayey or silty soils may be effectively ventilated by the usual levels of vacuum developed in a soil vapor extraction system.

In conjunction with soil properties, chemical properties will dictate whether a soil vapor extraction system is feasible. A vapor-phase vacuum extraction system is most effective at removing compounds that exhibit significant volatility at the ambient temperatures in soil, compounds exhibiting vapor pressures over 0.5 mm of mercury and compounds which have values of dimensionless Henry's Law constants greater than 0.01.

Technology status comments:

OHM has designed, fabricated, and operated a number of soil vapor extraction systems since 1980. These systems include both in situ and ex situ (soil pile) units.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Vendor services:

- ☒ Equipment manufacture
- ☒ Subcontractor for cleanup services
- ☒ Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

OHM's pilot scale soil vapor extraction unit contains all the elements required for installation of a treatment system on a single trailer. A vacuum pump pulls air saturated with volatile compounds from extraction wells or a soil pile. Condensate is removed in an air receiver vessel equipped with automatic level control to prevent liquid from entering the suction of the vacuum pump. Extracted air leaves the vacuum pump and is sent to a vapor treatment system. The vapor treatment system may include activated carbon, thermal destruction, catalytic destruction or UV/oxidation. Active or passive injection of air into the contaminated soil is also used.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Number of pilot-scale systems:

 Planned/in design
 Under construction
 3 Constructed

Pilot-scale facility is:

 X Transportable
 Fixed
 In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

 to

Can you conduct pilot-scale treatability studies on some type of waste
at your location? Yes

At a contaminated site? Yes

Quantity of waste needed for pilot-scale treatability study:

 10 to 100 Cubic yard

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Full-scale Equipment/Capabilities

Major unit processes:

OHM's soil vapor extraction system uses a vacuum pump to pull air saturated with volatile compounds from extraction wells or a soil pile. Make-up air to the soil may be actively or passively supplied. Condensate is removed from the vapor stream in an air receiver equipped with automatic level control to prevent liquid from entering the suction of the vacuum pump. Extracted air leaves the vacuum pump and is sent to a vapor treatment system prior to discharge. The vapor treatment system may include activated carbon, thermal destruction, catalytic destruction or UV/oxidation.

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Full-scale facility is:

☒ Transportable ☐ Fixed ☐ In situ

Full capacity range per hour:

100.00 to 20000.00 Cubic yard

Logistical requirements for transportable or in situ technologies:

Space (area).....: 1000 ft²

Water: gals. per day

Electrical power: 20 amps

480 volts

Natural gas.....: ft³ per day

Sewage access....: ☐ yes ☒ no

"Ballpark" estimate of price range per unit of waste treated:

40.00 to 100.00 per Ton

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Factors that have significant effect on unit price (1 is highest):

<u>1</u>	Initial contaminant concentration	<u>9</u>	Excavation
<u>2</u>	Target contaminant concentration	<u> </u>	Waste handling
<u>5</u>	Waste quantity	<u>10</u>	Permitting
<u>3</u>	Depth of contamination	<u> </u>	Pretreatment
<u>4</u>	Depth to ground water	<u> </u>	Amount of debris
<u>6</u>	Residual quantity	<u> </u>	Utility/fuel rates
<u>7</u>	Residual waste characteristics	<u> </u>	Labor rates
<u>8</u>	Site preparation		

Others:

[illegible]

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Number of full-scale cleanups initiated or completed by this firm
using this technology:

6

For equipment manufacturers - estimated or actual number of full-scale
cleanups by other firms using this equipment:

6

Major permits obtained for a full-scale system, and issuing
authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: RCRA
Issuing Authority.: Region IV

Permit Type.....: Air
Issuing Authority.: Bay Area Air Quality Mgmt Dist.

Permit Type.....: Air
Issuing Authority.: South Coast Air Quality Mgmt Dist.

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

1 Planned/in design

 Under construction

5 Constructed

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types
of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

 2

Description of bench-scale testing procedures:

Bench top scale treatability studies are conducted in a six
inch vertical soil column. Contaminated soil is placed into the
column above bead-type ceramic packing. Air passes through the
soil column and finally through activated carbon. The
effectiveness of the process can be calculated by comparing the
air flow rate to the quantity of contaminant adsorbed onto the
carbon. Flow rates can also be varied to optimize the treatment
process.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

VOCS

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
00.000 to 1000.000	ND to ND	Pilot scale

Waste description:

Soil contaminated with benzene, toluene, MEK, TCA, DCA, TCE

Soil classification:

gravel, sand, sandy loam

Comments:

Treated soil concentration not provided. Untreated off gas concentration was non-detectable.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

VOCS

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
00.000 to 1000.000	ND to ND	Full scale

Waste description:

Soil contaminated with benzene, toluene, MEK, TCA, DCA, TCE

Soil classification:

gravel, sand, sandy loam

Comments:

Treated soil concentration not provided. Untreated off gas concentration was non-detectable.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Tetrachloroethylene (PCE)

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
00.000 to 1000.000	< 20.000 to < 20.000	Full scale

Waste description:

Soil contaminated with dry cleaning chemicals

Soil classification:

sand, sandy clay

Comments:

Material met on-site disposal criteria.
Treated soil concentration was not provided. Untreated off gas
concentration was non-detectable.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Gasoline, BTEX

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
00.000 to 1200.000	< 10.000 to < 10.000	Full scale

Waste description:

Gasoline contaminated soil

Soil classification:

sand, sandy clay

Comments:

Material met on-site disposal criteria

SUMMARY OF PERFORMANCE DATA

Vendor name.....: OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Methylene Chloride

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
0.000 to 17650.000	ND to ND	Full scale

Waste description:

Methylene Chloride contaminated soil at former auto manufacturer

Soil classification:

sandy clay, silty clay

Comments:

Material to meet on-site disposal criteria.
Treated soil concentration not provided. Untreated off gas
concentration was non-detectable.

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Site name : Hinson Chemical

City : Hinson State: SC

Country : USA

Project type : RCRA

Client contact : _____

Affiliation : EPA Region IV

Phone number : () -

Equipment Scale:

☒ Bench scale

☐ Pilot scale

☐ Full scale

Project status (Month/Year):

Contracted : _____

Underway : _____

Completed/To be completed : 5/90

Waste description:

5,000 cubic yards VOC contaminated soil

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Site name : Hinson Chemical

City : Hinson State: SC

Country : USA

Project type : RCRA

Client contact : _____

Affiliation : EPA Region IV

Phone number : () -

Equipment Scale:

- ☐ Bench scale
- ☐ Pilot scale
- ☒ Full scale

Project status (Month/Year):

Contracted : 6/90

Underway : X

Completed/To be completed : _____

Waste description:

25,000 cubic yards VOC contaminated soil

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Site name : Vorelco

City : New Stanton State: PA

Country : USA

Project type : UST

Client contact : _____

Affiliation : PADER

Phone number : () -

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : 6/91

Underway : X

Completed/To be completed : _____

Waste description:

2,000 cubic yards methylene chloride contaminated soil

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Site name : _____

City : _____ State: _____

Country : USA

Project type : UST

Client contact : Confidential

Affiliation : _____

Phone number : () - _____

Equipment Scale:

- ☐ Bench scale
- ☐ Pilot scale
- ☒ Full scale

Project status (Month/Year):

Contracted : _____

Underway : _____

Completed/To be completed : 5/91

Waste description:

300 cubic yards gasoline contaminated soil

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Site name : _____

City : _____ State: _____

Country : USA

Project type : UST

Client contact : Confidential

Affiliation : _____

Phone number : () - _____

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : _____

Underway : _____

Completed/To be completed : 6/90

Waste description:

500 cubic yards gasoline contaminated soil

AVAILABLE REFERENCES

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Reference: Hutzler, N.J., et al., "Review of Soil Vapor
Extraction System Technology" Presented at "Soil Vapor Extraction
Technology for UST Sites Workshop" June 27-28 1989

Source:

Name/Organization: USEPA Risk Reduction Engineering Lab

Address: _____

City : Edison

State : NJ

Zip : _____

Phone number: () - _____

AVAILABLE REFERENCES

Vendor name : OHM CORPORATION

Technology type: SOIL VAPOR EXTRACTION

Reference: Johnson, P.C., et al., "A Practical Approach to the
Design, Operation, and Monitoring of In Situ Soil Venting Systems"

Source:

Name/Organization: National Water Well Association

Address: 4375 Riverside Drive

City : Dayton

State : OH

Zip : 43107

Phone number: () -

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 02/27/92

Developer/Vendor name: TERRA VAC

Street address: 356 Fortaleza Street

City: San Juan State: PR Zip: 00901

Country: USA

Contact name: JOSEPH A. PEZZULLO, P.E.

and title...: VICE PRESIDENT

Contact phone: (609) 530-0003 Fax Number: (609) 530-1084

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? Yes

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

General description of technology:

Vacuum extraction induces a negative pressure gradient within the soil matrix through extraction wells. As the vacuum propagates through the subsurface, the contaminants vaporize as air and contaminant vapors migrate toward the extraction well(s) where they are drawn to the surface for treatment.

The process recovers all phases of contamination: 1) vapor; 2) liquid; 3) dissolved; 4) adsorbed. Liquid water is generally extracted along with the contaminated vapor. The two-phase flow of contaminated air and water flows to a vapor/liquid separator where the contaminated water is removed. The contaminated air stream is then treated via carbon adsorption or catalytic oxidation. The contaminated water from the separator is treated by any one of many water treatment technologies.

As contaminant vapors are removed from the soil's pore volume, the other three phases (liquid, dissolved, adsorbed) vaporize in place, thereby reducing the aggregate soil concentration. Hence, this process is continuous, as the contaminants are constantly driven to the vapor state within the soil matrix.

[illegible]

Part 1: General Information and Technology Overview (continued)

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Technology highlights:

There are several key advantages to the vacuum extraction process which revolve around the flexibility of its application. It can be performed in-situ (e.g., underneath buildings, roads, parking lots, or other structures), or ex-situ in soil piles.

Vacuum extraction can be combined with groundwater extraction from the same wells. This synergistic process provides a cost-effective means of recovering contaminants from the vadose zone and groundwater without having to install two separate systems.

It can be combined with hot air injection, steam injection, electric soil heating or air sparging to enhance the volatility of the contaminants. Also, the vast amounts of air being purged through the soils has shown to enhance the natural biodegradation of certain contaminants.

Vacuum extraction is a proven technology that works in virtually every type of soil throughout a wide range of permeabilities. It has also been effective in fractured bedrock. It can be applied to volatile and semi-volatile contaminants. Furthermore, once operational parameters have been defined and set, the treatment can continue unsupervised with scheduled maintenance and system monitoring.

[illegible]

Part 1: General Information and Technology Overview (continued)

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- ☒ Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- ☒ Soil
- ☒ Sludge
- Solid
- Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

General sources or types of industrial waste or contaminated sites
that the technology can address:

- | | |
|--|--|
| <input type="checkbox"/> Agriculture | <input type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input type="checkbox"/> Coal gasification | <input type="checkbox"/> Photographic products |
| <input type="checkbox"/> Dry cleaners | <input checked="" type="checkbox"/> Plastics manufacturing |
| <input checked="" type="checkbox"/> Electroplating | <input type="checkbox"/> Pulp and paper industry |
| <input type="checkbox"/> Herbicide manufacturing/use | <input checked="" type="checkbox"/> Other organic chemical manufacturing |
| <input checked="" type="checkbox"/> Industrial landfills | <input type="checkbox"/> Other inorganic chemical manufacturing |
| <input type="checkbox"/> Inorganic/organic pigments | <input checked="" type="checkbox"/> Semiconductor manufacturing |
| <input checked="" type="checkbox"/> Machine shops | <input type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input checked="" type="checkbox"/> Wood preserving |
| <input checked="" type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input type="checkbox"/> Munitions Manufacturing | |

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Technology limitations:

This technology is not applicable where the Henry's constant of the contaminant is less than 0.0001.

Technology status comments:

Terra Vac is in the process of testing the effectiveness of vacuum extraction in combination with other treatment technologies such as bioremediation. Also, our research includes testing the effectiveness of vacuum extraction to remove mercury contamination.

Detailed Information and Performance Data

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Vendor services:

- X Equipment manufacture
- X Subcontractor for cleanup services
- X Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

Major components include extraction wells, manifold piping, vapor/liquid separator, activated carbon units or catalytic oxidizer, vacuum unit, manifold piping and instrumentation. Some applications include groundwater pumps and controls, telemetry circuits and auto-sampling devices.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Number of pilot-scale systems:

15 Planned/in design
20 Under construction
250 Constructed

Pilot-scale facility is:

☐ Transportable
☐ Fixed
☒ In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

_____ to _____ N/A

Can you conduct pilot-scale treatability studies on some type of waste at your location? No

At a contaminated site? Yes

Quantity of waste needed for pilot-scale treatability study:

_____ to _____ N/A

Number of pilot-scale studies conducted on wastes from different sources or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Full-scale Equipment/Capabilities

Major unit processes:

Major components include extraction wells, manifold piping, vapor/liquid separator, activated carbon units or catalytic oxidizer, vacuum unit, manifold piping and instrumentation. Some applications include groundwater pumps and controls, telemetry circuits and auto-sampling devices.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Full-scale facility is:

☐ Transportable ☐ Fixed ☒ In situ

Full capacity range per hour:

 to N/A

Logistical requirements for transportable or in situ technologies:

Space (area).....: 200 ft²

Water: gals. per day

Electrical power: 100 amps

 440 volts

Natural gas.....: ft³ per day

Sewage access...: ☐ yes ☒ no

"Ballpark" estimate of price range per unit of waste treated:

10.00 to 100.00 per Ton

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Factors that have significant effect on unit price (1 is highest):

<u>4</u>	Initial contaminant concentration	<u> </u>	Excavation
<u>1</u>	Target contaminant concentration	<u> </u>	Waste handling
<u>5</u>	Waste quantity	<u>8</u>	Permitting
<u>3</u>	Depth of contamination	<u> </u>	Pretreatment
<u>2</u>	Depth to ground water	<u> </u>	Amount of debris
<u>6</u>	Residual quantity	<u>9</u>	Utility/fuel rates
<u>7</u>	Residual waste characteristics	<u>10</u>	Labor rates
<u> </u>	Site preparation		

Others:

[illegible]

Detailed Information and Performance Data (continued)

Vendor name....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Number of full-scale cleanups initiated or completed by this firm using this technology:

200

For equipment manufacturers - estimated or actual number of full-scale cleanups by other firms using this equipment:

Major permits obtained for a full-scale system, and issuing authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: Air Quality
Issuing Authority.: _____Permit Type.....: NPDES
Issuing Authority.:

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

30 Planned/in design

50 Under construction

100 Constructed

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types
of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

10

Description of bench-scale testing procedures:

Bench-scale testing involves collecting a sample of the
contaminated soil in cores, buckets or drums. These vessels are
then connected to similar apparatus as described in 23a, only
smaller. The vacuum system is started, and analytical sampling
of the soil and extracted vapors throughout the test is used to
evaluate the effectiveness of the treatment process.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

BTEX

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
10.000 to 3000.000	0.001 to 0.005	Full scale

Waste description:

Gasoline station, leaking UST

Soil classification:

Sand

Comments:

Recovered 50,000 lbs of gasoline in 6 months.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Trichloroethylene (TCE), Tetrachloroethylene (PCE)

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
5.000 to 5000.000	0.001 to 0.005	Full scale

Waste description:

Superfund Region IV, VOC-contaminated soils

Soil classification:

Sand/silt

Comments:

Recovered 60,000 lbs, initial rate of 4,440 lbs/day.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Carbon Tetrachloride

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
3.000 to 600.000	0.000 to 0.001	Full scale

Waste description:

Superfund Region II, contaminated clay and rock.

Soil classification:

Clay and rock

Comments:

First-ever application of technology at a Superfund site. Reached non-detectable level in 2.5 years. Completed.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Tricresyl Phosphate (TCP)

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
10.000 to 200000.000	N/A to N/A	Full scale

Waste description:

Superfund Region III, semi-volatile contaminated soils and groundwater.

Soil classification:

Clay and bedrock.

Comments:

On-going project. Recovered 150,000 lbs to date, including DNAPL.
Dual extraction of soils and groundwater.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

VOCS (Acetone, Toluene, MeCl)

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
3.000 to 400.000	N/A to N/A	Full scale

Waste description:

Tank farm leakage. Contaminated backfill.

Soil classification:

Sand and gravel.

Comments:

Achieved non-detectable levels within 60 days. Closure within 90 days thereafter.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Dichlorobenzene (DCB)

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
10.000 to 200000.000	N/A to N/A	Full scale

Waste description:

Superfund Region III, semi-volatile contaminated soils and groundwater.

Soil classification:

Clay and bedrock.

Comments:

On-going project. Recovered 150,000 lbs to date, including DNAPL.
Dual extraction of soils and groundwater.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Contaminant, contaminant group, or pollutant parameter:

Xylene

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
10.000 to 200000.000	N/A to N/A	Full scale

Waste description:

Superfund Region III, semi-volatile contaminated soils and groundwater.

Soil classification:

Clay and bedrock.

Comments:

On-going project. Recovered 150,000 lbs to date, including DNAPL.
Dual extraction of soils and groundwater.

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Site name : Groveland Wells *

City : Groveland State: MA

Country : USA

Project type : SUPERFUND US EPA SITE DEMO

Client contact : Mary Stinson

Affiliation : US EPA - RREL

Phone number : (908) 321-6683

Equipment Scale:

☐ Bench scale

☒ Pilot scale

☐ Full scale

Project status (Month/Year):

Contracted : 12/87

Underway :

Completed/To be completed : 07/89

Waste description:

Leaking UST, TCE-contaminated soils and groundwater

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Site name : Union 76 Gasoline Station

City : Belleview State: FL

Country : USA

Project type : FLORIDA DEPT. OF ENVIR. REGUL.

Client contact : Joseph Applegate, John Gentry

Affiliation : Florida DER

Phone number : () -

Equipment Scale:

- ☐ Bench scale
- ☐ Pilot scale
- ☒ Full scale

Project status (Month/Year):

Contracted : 09/88

Underway :

Completed/To be completed :

Waste description:

Gasoline-contaminated soils, 10,000 gallons

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Site name : Tysons Dump *

City : King of Prussia State: PA

Country : USA

Project type : SUPERFUND/PRIVATE LEAD

Client contact : Karline Tierney

Affiliation : Ciba-Geigy

Phone number : (914) 479-5000

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : 01/88

Underway : X

Completed/To be completed :

Waste description:

Benzene, toluene, xylene, trichloropropane in soil and DNAPL

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Site name : Upjohn Facility *

City : Barcelonetta State: PR

Country : USA

Project type : SUPERFUND/PRIVATE LEAD

Client contact : _____

Affiliation : _____

Phone number : () - _____

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : 05/84

Underway : _____

Completed/To be completed : 11/86

Waste description:

CCl4-contaminated clay and bedrock

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Site name : Verona Well Field *

City : Battle Creek, State: MI

Country : USA

Project type : SUPERFUND/EPA LEAD

Client contact : Joseph Danko

Affiliation : CH2M Hill

Phone number : (503) 752-0276

Equipment Scale:

- ☐ Bench scale
- ☐ Pilot scale
- ☒ Full scale

Project status (Month/Year):

Contracted : 08/87

Underway : X

Completed/To be completed :

Waste description:

PCE, TCE, MEK, CCl₄, MeCl, MEK, MIBK, BTEX-contaminated sand and silt

AVAILABLE REFERENCES

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Reference: SITE Program Demonstration Test, Terra Vac In-Situ
Vacuum Extraction System, Groveland, MA, Report 540-5-89-003a

Source:

Name/Organization: Mary Stinson/U.S. EPA - ORD

Address: Releases Control Branch

MS-104

City : Edison,

State : NJ

Zip : 08837

Phone number: (201) 321-6683

AVAILABLE REFERENCES

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Reference: U.S. Patent and Trademark Office, Number Re. 33,102

Source:

Name/Organization: U. S. Patent and Trademark Office

Address: 2021 Jefferson Davis Highway

City : Arlington,

State : VA

Zip : 22202

Phone number: (703) 557-4636

AVAILABLE REFERENCES

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Reference: Malot, James J., 1988, Clean Up of Soils Contaminated
with Hydrocarbons at a Gasoline Service Station

Source:

Name/Organization: Air and Waste Management Association

Address: 3 Gateway Center, Publications Dept. 4th Floor

(Paper No. 88-3.7)

City : Pittsburgh,

State : PA

Zip : 15222

Phone number: (412) 232-3444

AVAILABLE REFERENCES

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Reference: Fuerst, David, et al., 1991, Vacuum Extraction of
Volatile and Semi-Volatile Compounds at a Superfund Site

Source:

Name/Organization: HMCRI Conference, Houston, TX, July

Address: 7237 Hanover Parkway

City : Greenbelt

State : MD

Zip : 207703602

Phone number: (301) 982-9500

AVAILABLE REFERENCES

Vendor name : TERRA VAC

Technology type: SOIL VAPOR EXTRACTION

Reference: Pezzullo, Joseph A., Peterson, R. Michael, Malot,
James J., 1990, Full Scale Remediation at a Superfund Site Using
In-Situ Vacuum Extraction and On-Site Regeneration, Case Study-Phase I

Source:

Name/Organization: HMCRI Superfund Conf., Wash., DC, Nov.

Address: 7237 Hanover Parkway

City : Greenbelt,

State : MD

Zip : 207703602

Phone number: (301) 982-9500

**VISITT INFORMATION
FOR
BIOLOGICALLY ENHANCED ISVE**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 10/07/91

Developer/Vendor name: BATTELLE MEMORIAL INSTITUTE

Street address: Battelle Blvd., Box 999

City: Richland State: WA Zip: 99352

Country: USA

Contact name: DAN ANDERSON , ROB HINCHEE

and title...: BATTELLE PNL , BATTELLE - COLUMBUS

Contact phone: (509) 376-9428 Fax Number: (509) 376-1867

Telex number: () -

Standard technology type:

BIOVENTING

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? No

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: BATTELLE MEMORIAL INSTITUTE

Technology type: BIOVENTING

General description of technology:

Battelle - Columbus has developed and is currently deploying a vacuum-enhanced in-situ bioremediation (bioventing) technology with PNL to remediate jet fuel contaminated sites. Bioventing technology removes volatile organic compounds (VOCs) from subsurface soils while simultaneously stimulating aerobic biodegradation of semi-volatile compounds by controlling mass transfer and availability of oxygen.

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09/18/92

Part 1: General Information and Technology Overview (continued)

Vendor name....: BATTELLE MEMORIAL INSTITUTE

Technology type: BIOVENTING

Technology highlights:

*Enhancement to vapor extraction for volatile and semi-volatile components.

*Field treatability (in-situ) capability to reduce cost of treatability/feasibility studies.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE MEMORIAL INSTITUTE

Technology type: BIOVENTING

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- ☒ Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- ☒ Soil
- Sludge
- Solid
- ☒ Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE MEMORIAL INSTITUTE

Technology type: BIOVENTING

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Diesel fuel, jet fuel, other petroleum hydrocarbons.

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE MEMORIAL INSTITUTE

Technology type: BIOVENTING

General sources or types of industrial waste or contaminated sites that the technology can address:

- | | |
|--|--|
| <input checked="" type="checkbox"/> Agriculture | <input type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input type="checkbox"/> Coal gasification | <input type="checkbox"/> Photographic products |
| <input type="checkbox"/> Dry cleaners | <input type="checkbox"/> Plastics manufacturing |
| <input type="checkbox"/> Electroplating | <input type="checkbox"/> Pulp and paper industry |
| <input type="checkbox"/> Herbicide manufacturing/use | <input type="checkbox"/> Other organic chemical manufacturing |
| <input type="checkbox"/> Industrial landfills | <input type="checkbox"/> Other inorganic chemical manufacturing |
| <input type="checkbox"/> Inorganic/organic pigments | <input type="checkbox"/> Semiconductor manufacturing |
| <input type="checkbox"/> Machine shops | <input type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input type="checkbox"/> Wood preserving |
| <input type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input type="checkbox"/> Munitions Manufacturing | |

Others:

UST sites

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE MEMORIAL INSTITUTE

Technology type: BIOVENTING

Technology limitations:

Technology is currently applicable to volatile and semi-volatile organic contaminants that can be aerobically biodegraded. Limited applicability to co-metabolically degraded contaminants such as TCE. Performance is affected by the number and diversity of indigenous microorganisms, pH, temperature, and soil moisture.

Technology status comments:

Battelle has demonstrated the technology in the field at contaminated sites and is currently involved in several field-scale demonstrations.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 09/23/91

Developer/Vendor name: GROUNDWATER TECHNOLOGY, INC.

Street address: 100 River Ridge Drive

City: Norwood State: MA Zip: 02062

Country: USA

Contact name: Richard Brown, Ph.D.

and title...: Director, Geochemical Bioremediation Tech

Contact phone: (609) 587-0300

Fax Number: () -

Telex number: () -

Standard technology type:

BIOVENTING

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? No

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

General description of technology:

Bioaugmented soil vapor extraction is the removal of volatile organic compounds from unsaturated soils by forced aeration and nutrient augmentation. The technology results both in the physical removal of VOCs through enhanced volatilization and in the biodegradation of organic compounds through the acceleration of indigenous microbial processes. The key to the process is the effective contact of contaminated soil with an induced air stream. The partitioning of the process between physical removal and biodegradation is a function of the rate of aeration and the relatively biodegradability of the material being treated.

Combining physical removal with biodegradation accelerates remediation and allows for the achievement of lower closure levels. The system can be applied both in situ and ex situ.

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Part 1: General Information and Technology Overview (continued)

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Technology highlights:

Bioaugmented soil vapor extraction extends the range of contaminants that can be effectively treated through vapor extraction. It has been demonstrated effective in treating chlorinated hydrocarbons. Bioaugment soil vapor is effective in treating chlorinated organics and is also faster than conventional technologies because it combines two remedial technologies - volatilization and biodegradation.

Part 1: General Information and Technology Overview (continued)

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- X Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- X Soil
- X Sludge
- Solid
- Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input checked="" type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

General sources or types of industrial waste or contaminated sites
that the technology can address:

- | | |
|---|--|
| <input checked="" type="checkbox"/> Agriculture | <input checked="" type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input checked="" type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input checked="" type="checkbox"/> Coal gasification | <input checked="" type="checkbox"/> Photographic products |
| <input checked="" type="checkbox"/> Dry cleaners | <input checked="" type="checkbox"/> Plastics manufacturing |
| <input type="checkbox"/> Electroplating | <input checked="" type="checkbox"/> Pulp and paper industry |
| <input checked="" type="checkbox"/> Herbicide manufacturing/use | <input checked="" type="checkbox"/> Other organic chemical manufacturing |
| <input checked="" type="checkbox"/> Industrial landfills | <input type="checkbox"/> Other inorganic chemical manufacturing |
| <input type="checkbox"/> Inorganic/organic pigments | <input type="checkbox"/> Semiconductor manufacturing |
| <input type="checkbox"/> Machine shops | <input checked="" type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input checked="" type="checkbox"/> Wood preserving |
| <input checked="" type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input type="checkbox"/> Munitions Manufacturing | |

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Technology limitations:

The two limitations to the technology are the ability to aerate the soil/solid matrix and the properties of the contaminant. If the permeability is too low or if the contaminant is both nondegradable and nonvolatile, bioaugment soil vapor extraction will not be effective.

Technology status comments:

Bioaugmented soil vapor extraction has been successfully applied on a commercial scale to treat petroleum hydrocarbons such as gasoline and diesel; organic chemicals such as chlorobenzene and numerous chlorinated solvents ex situ. It has been used to treat soils in volumes of a few hundred cubic yards to tens of thousands. In situ bioremediation has been used to treat sites ranging in size from less than one acre to over 50 acres.

Detailed Information and Performance Data

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Vendor services:

- X Prime contractor for full-service remediation**

Pilot-scale Equipment/Capabilities

Major unit processes:

The full-scale equipment system can be used for pilot-scale systems.

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Number of pilot-scale systems:

_____ Planned/in design
_____ Under construction
_____ Constructed

Pilot-scale facility is:

_ Transportable
_ Fixed
_ In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

_____ to _____

Can you conduct pilot-scale treatability studies on some type of waste
at your location? No

At a contaminated site? No

Quantity of waste needed for pilot-scale treatability study:

_____ to _____

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Full-scale Equipment/Capabilities

Major unit processes:

Ex situ system consists of a aeration bed-gravel layer with a aeration pipe which is placed on a soil pile. The pile is constructed around vacuum piping which is on 3 foot centers and are connected to a vacuum pump. Nutrient infiltration is accomplished through infiltration pipe.

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Full-scale facility is:

☒ Transportable ☐ Fixed ☒ In situ

Full capacity range per hour:

_____ to _____

Logistical requirements for transportable or in situ technologies:

Space (area).....: _____ ft²

Water: _____ gals. per day

Electrical power: _____ 100 amps

_____ 120 volts

Natural gas.....: _____ ft³ per day

Sewage access....: ☐ yes ☒ no

"Ballpark" estimate of price range per unit of waste treated:

100.00 to 120.00 per Cubic yard

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Factors that have significant effect on unit price (1 is highest):

<u>1</u>	Initial contaminant concentration	<u>8</u>	Excavation
<u>3</u>	Target contaminant concentration	___	Waste handling
<u>2</u>	Waste quantity	<u>9</u>	Permitting
<u>4</u>	Depth of contamination	___	Pretreatment
<u>5</u>	Depth to ground water	___	Amount of debris
<u>6</u>	Residual quantity	___	Utility/fuel rates
___	Residual waste characteristics	<u>10</u>	Labor rates
<u>7</u>	Site preparation		

Others:

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Number of full-scale cleanups initiated or completed by this firm
using this technology:

50

For equipment manufacturers - estimated or actual number of full-scale
cleanups by other firms using this equipment:

50

Major permits obtained for a full-scale system, and issuing
authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: NPDES
Issuing Authority.: NJ, MI, CA, NY, MA

Permit Type.....: Air Permits
Issuing Authority.: CA

Permit Type.....: Consent Orders - EPA
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

12 Planned/in design

20 Under construction

18 Constructed

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types
of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

50

Description of bench-scale testing procedures:

Bench scale studies consist of loading columns with soil, adding
nutrients and measuring rates of removal due to volatilization or
biodegradation during aeration. Air permeability must be
measured in the field for in situ system, air permeability for ex
situ can be measured by pressure drop and flow through column.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Contaminant, contaminant group, or pollutant parameter:

Gasoline

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
1500.000 to 2000.000	0.001 to 10.000	Full scale

Waste description:

Contaminated soil (8000 pounds)

Soil classification:

Sands & silts

Comments:

In situ system operated for 28 months. Over 7000 lbs. of containment were removed.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: GROUNDWATER TECHNOLOGY, INC.

Technology type: BIOVENTING

Contaminant, contaminant group, or pollutant parameter:

Diesel

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
5000.000 to 14000.000	10.000 to 50.000	Full scale

Waste description:

River sediments 7000 yards from tanker leak

Soil classification:

Silts & clays

Comments:

In situ system operated for 2 months. Closure was soil on site.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 09/30/91

Developer/Vendor name: IT CORPORATION

Street address: 312 Directors Drive

City: Knoxville State: TN Zip: 37923

Country: USA

Contact name: Maureen Leavitt

and title...: Technical Coordinator

Contact phone: (615) 690-3211 Fax Number: (615) 690-3626

Telex number: () -

Standard technology type:

BIOVENTING

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? No

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

General description of technology:

This technology is derived from soil vapor extraction technology. An air circulation system is established in the unsaturated zone of the given matrix (usually soil). Air movement throughout the contaminated area provides oxygen for the biodegradation process. A specially designed nutrient delivery system is attached to provide vapor-phase ammonia and phosphorus to the subsurface. Together, these substrates provide the essential requirements to stimulate indigenous bacteria to biodegrade contaminants in unsaturated matrices. This technology can be run continuously, or in batch form.

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Part 1: General Information and Technology Overview (continued)

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

Technology highlights:

Vacuum-enhanced in situ bioremediation is an excellent remedial alternative when excavation is not an option, and the impacted soil is unsaturated. Although it can be effective in the destruction of volatile organics, it has the best advantage when the contaminants are semi- or non-volatile. These classes of contaminants are not affected with SVE alone. A system can be optimized to operate with minimal contaminated air emissions, avoiding extensive carbon consumption or extensive air permitting. It can be effective on any contaminant that is readily biodegraded. Many of the transport limitations associated with aqueous delivery systems or saturated soils are avoided with this technology.

[illegible]

Part 1: General Information and Technology Overview (continued)

Vendor name.....: IT CORPORATION

Technology type: BIOVENTING

Technology status:

- ☐ Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- ☒ Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- ☐ Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- ☒ Soil
- ☒ Sludge
- ☒ Solid
- ☒ Natural sediment
- ☐ Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name.....: IT CORPORATION

Technology type: BIOVENTING

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input checked="" type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input checked="" type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input checked="" type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input checked="" type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: IT CORPORATION

Technology type: BIOVENTING

General sources or types of industrial waste or contaminated sites
that the technology can address:

- | | |
|---|--|
| <input checked="" type="checkbox"/> Agriculture | <input checked="" type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input checked="" type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input checked="" type="checkbox"/> Coal gasification | <input checked="" type="checkbox"/> Photographic products |
| <input checked="" type="checkbox"/> Dry cleaners | <input checked="" type="checkbox"/> Plastics manufacturing |
| <input type="checkbox"/> Electroplating | <input checked="" type="checkbox"/> Pulp and paper industry |
| <input checked="" type="checkbox"/> Herbicide manufacturing/use | <input checked="" type="checkbox"/> Other organic chemical manufacturing |
| <input checked="" type="checkbox"/> Industrial landfills | <input type="checkbox"/> Other inorganic chemical manufacturing |
| <input checked="" type="checkbox"/> Inorganic/organic pigments | <input checked="" type="checkbox"/> Semiconductor manufacturing |
| <input checked="" type="checkbox"/> Machine shops | <input checked="" type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input checked="" type="checkbox"/> Wood preserving |
| <input checked="" type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input checked="" type="checkbox"/> Munitions Manufacturing | |

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: IT CORPORATION

Technology type: BIOVENTING

Technology limitations:

This technology may be limited ultimately by the physical configuration of the matrix. Since there is no mixing or perturbation generally caused by water movement, there is a chance that bacteria/contaminant contact may be limited.

Technology status comments:

PART 2: Pilot- and Full-scale Technologies: Detailed Information and Performance Data

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

Vendor services:

- Equipment manufacture
X Subcontractor for cleanup services
X Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

The major components of the pilot system are the ammonia source tank, the inlet pipe, the distribution manifold, the extraction pipes, and the vacuum pump. The vacuum pump outlet can be connected to activated carbon canisters if necessary.

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

Number of pilot-scale systems:

3 Planned/in design

1 Under construction

1 Constructed

Pilot-scale facility is:

 Transportable

 Fixed

X In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

 to

Can you conduct pilot-scale treatability studies on some type of waste
at your location? Yes

At a contaminated site? Yes

Quantity of waste needed for pilot-scale treatability study:

1 to 50 Kilograms

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

1

Detailed Information and Performance Data (continued)

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

Full-scale Equipment/Capabilities

Major unit processes:

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

Full-scale facility is:

☐ Transportable ☐ Fixed ☐ In situ

Full capacity range per hour:

_____ to _____

Logistical requirements for transportable or in situ technologies:

Space (area)....: _____ ft²

Water: _____ gals. per day

Electrical power: _____ amps

_____ volts

Natural gas.....: _____ ft³ per day

Sewage access...: ☐ yes ☐ no

"Ballpark" estimate of price range per unit of waste treated:

N/A to _____ per _____

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

**PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)**

Vendor name....: IT CORPORATION

Technology type: BIOVENTING

Factors that have significant effect on unit price (1 is highest):

___ Initial contaminant concentration	___ Excavation
___ Target contaminant concentration	___ Waste handling
___ Waste quantity	___ Permitting
___ Depth of contamination	___ Pretreatment
___ Depth to ground water	___ Amount of debris
___ Residual quantity	___ Utility/fuel rates
___ Residual waste characteristics	___ Labor rates
___ Site preparation	

Others:

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: IT CORPORATION

Technology type: BIOVENTING

Number of full-scale cleanups initiated or completed by this firm
using this technology:

For equipment manufacturers - estimated or actual number of full-scale
cleanups by other firms using this equipment:

Major permits obtained for a full-scale system, and issuing
authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

_____ Planned/in design

_____ Under construction

_____ Constructed

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: IT CORPORATION

Technology type: BIOVENTING

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types
of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

3

Description of bench-scale testing procedures:

Initially, a bioassessment is completed to determine that an adequate bacterial population exists, and that all environmental parameters that influence bioremediation are within the preferred ranges. Second, if required, a bench-scale column study is conducted to demonstrate nutrient transport in the specific matrix to be treated.

**VISITT INFORMATION
FOR
THERMALLY ENHANCED ISVE**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 10/06/91

Developer/Vendor name: EM&C ENGINEERING ASSOCIATES

Street address: 1665 Scenic Ave., Suite 104

City: Costa Mesa State: CA Zip: 92626

Country: USA

Contact name: Mohamed Elgafi

and title...: President

Contact phone: (714) 957-6429

Fax Number: (714) 957-6414

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? No

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: EM&C ENGINEERING ASSOCIATES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General description of technology:

The process will require the installation of a grid of injection wells and recovery wells at select locations in between. Steam is injected through the injection wells. The pressure gradient between the injection wells and recovery wells will provide the driving force for steam to flow. The steam flood will vaporize volatiles and drive out nonvolatiles in a fashion similar to any steam stripping process. Vapors will be collected and condensed for off-site treatment.

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Part 1: General Information and Technology Overview (continued)

Vendor name....: EM&C ENGINEERING ASSOCIATES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology highlights:

(1) We have capable and experienced staff and we can respond to potential customers in the same week of the inquiry.

(2) The technology was developed with the purpose of wood preservation sites in mind and it is our target market for the application.

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Part 1: General Information and Technology Overview (continued)

Vendor name.....: EM&C ENGINEERING ASSOCIATES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- X Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- X Soil
- X Sludge
- X Solid
- Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name.....: EM&C ENGINEERING ASSOCIATES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input checked="" type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: EM&C ENGINEERING ASSOCIATES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General sources or types of industrial waste or contaminated sites
that the technology can address:

- | | |
|---|--|
| <input type="checkbox"/> Agriculture | <input type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input checked="" type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input type="checkbox"/> Coal gasification | <input type="checkbox"/> Photographic products |
| <input type="checkbox"/> Dry cleaners | <input checked="" type="checkbox"/> Plastics manufacturing |
| <input type="checkbox"/> Electroplating | <input type="checkbox"/> Pulp and paper industry |
| <input checked="" type="checkbox"/> Herbicide manufacturing/use | <input type="checkbox"/> Other organic chemical manufacturing |
| <input type="checkbox"/> Industrial landfills | <input type="checkbox"/> Other inorganic chemical manufacturing |
| <input type="checkbox"/> Inorganic/organic pigments | <input type="checkbox"/> Semiconductor manufacturing |
| <input type="checkbox"/> Machine shops | <input checked="" type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input checked="" type="checkbox"/> Wood preserving |
| <input type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input type="checkbox"/> Munitions Manufacturing | |

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: EM&C ENGINEERING ASSOCIATES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology limitations:

The technology is limited only by the critical pressure of steam; there are approximately 3000 psi available to work with in terms of pressure drop. We are also limited by steam temperature. We can treat a vast range of organic pollutants. The process is very effective whenever pollutants form azeotropes with water.

Technology status comments:

Steamflood is an old technology utilized for enhanced oil recovery from relatively shallow oil fields, and now revisited for applications on much shallower applications.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 09/30/91

Developer/Vendor name: BATTELLE PACIFIC NORTHWEST LABORATORIES

Street address: P.O. Box 999
Mail Stop P7-41

City: Richland State: WA Zip: 99352

Country: USA

Contact name: Bill Heath

and title...: Development Engineer

Contact phone: (509) 376-0554 Fax Number: (509) 376-1867

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? No

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General description of technology:

In-situ heating is a process which uses common AC electricity to heat soils as a means of significantly improving the performance of conventional soil-venting techniques. By heating the contaminant and soil, the contaminant's vapor pressure is increased to the extent that it diffuses faster into vented air. In addition, by heating the soil to the point where water boils, steam is created which can allow the stripping of semi-volatiles or potentially non-volatile components. The drying of the soil also increases its permeability and hence enables greater removal via venting. The treatment process uses common AC electricity applied to an electrode array placed in the soil. Standard soil venting techniques are used to remove the resulting vapors.

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Part 1: General Information and Technology Overview (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology highlights:

1. This is an in situ process. Little disturbance of the affected soil is required.
2. The process uses common AC electricity. Capital costs are low compared to other soil heating technologies.
3. Because the soil can be heated to the boiling point of water, higher boiling contaminants (semi-volatiles and potentially non-volatiles) can also be removed.

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology status:

- ☒ Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- ☐ Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- ☐ Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- ☒ Soil
- ☒ Sludge
- ☐ Solid
- ☐ Natural sediment
- ☐ Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input checked="" type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Nitrate

Part 1: General Information and Technology Overview (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General sources or types of industrial waste or contaminated sites
that the technology can address:

<input checked="" type="checkbox"/> Agriculture	<input type="checkbox"/> Paint/ink formulation
<input type="checkbox"/> Battery recycling/disposal	<input checked="" type="checkbox"/> Pesticide manufacturing/use
<input type="checkbox"/> Chloro-alkali manufacturing	<input checked="" type="checkbox"/> Petroleum refining and reuse
<input checked="" type="checkbox"/> Coal gasification	<input type="checkbox"/> Photographic products
<input checked="" type="checkbox"/> Dry cleaners	<input checked="" type="checkbox"/> Plastics manufacturing
<input type="checkbox"/> Electroplating	<input type="checkbox"/> Pulp and paper industry
<input checked="" type="checkbox"/> Herbicide manufacturing/use	<input type="checkbox"/> Other organic chemical manufacturing
<input checked="" type="checkbox"/> Industrial landfills	<input type="checkbox"/> Other inorganic chemical manufacturing
<input checked="" type="checkbox"/> Inorganic/organic pigments	<input type="checkbox"/> Semiconductor manufacturing
<input checked="" type="checkbox"/> Machine shops	<input checked="" type="checkbox"/> Rubber manufacturing
<input type="checkbox"/> Metal ore mining and smelting	<input checked="" type="checkbox"/> Wood preserving
<input checked="" type="checkbox"/> Municipal Landfill	<input type="checkbox"/> Uranium mining
<input type="checkbox"/> Munitions Manufacturing	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology limitations:

In situ heating is limited by the temperature to which the soil can be heated. High boiling contaminants can not be treated.

Technology status comments:

PART 2: Pilot- and Full-scale Technologies: Detailed Information and Performance Data

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Vendor services:

- Equipment manufacture
- Subcontractor for cleanup services
- Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

[illegible]

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Number of pilot-scale systems:

_____ Planned/in design
_____ Under construction
_____ Constructed

Pilot-scale facility is:

_ Transportable
_ Fixed
_ In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

_____ to _____

Can you conduct pilot-scale treatability studies on some type of waste
at your location? No

At a contaminated site? No

Quantity of waste needed for pilot-scale treatability study:

_____ to _____

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Full-scale Equipment/Capabilities

Major unit processes:

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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Full-scale facility is:

☐ Transportable ☐ Fixed ☐ In situ

Full capacity range per hour:

_____ to _____

Logistical requirements for transportable or in situ technologies:

Space (area).....: _____ ft²

Water: _____ gals. per day

Electrical power: _____ amps

_____ volts

Natural gas.....: _____ ft³ per day

Sewage access....: ☐ yes ☐ no

"Ballpark" estimate of price range per unit of waste treated:

N/A to _____ per _____

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Factors that have significant effect on unit price (1 is highest):

___ Initial contaminant concentration	___ Excavation
___ Target contaminant concentration	___ Waste handling
___ Waste quantity	___ Permitting
___ Depth of contamination	___ Pretreatment
___ Depth to ground water	___ Amount of debris
___ Residual quantity	___ Utility/fuel rates
___ Residual waste characteristics	___ Labor rates
___ Site preparation	

Others:

[illegible]

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Number of full-scale cleanups initiated or completed by this firm
using this technology:

For equipment manufacturers - estimated or actual number of full-scale
cleanups by other firms using this equipment:

Major permits obtained for a full-scale system, and issuing
authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

___ 1 Planned/in design

___ Under construction

___ Constructed

Detailed Information and Performance Data (continued)

Vendor name....: BATTELLE PACIFIC NORTHWEST LABORATORIES

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types of waste at your location: ☒ yes ☐ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

Description of bench-scale testing procedures:

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 05/16/91

Developer/Vendor name: NOVATERRA

Street address: 373 Van Ness Avenue, Suite 210

City: Torrance State: CA Zip: 90501

Country: USA

Contact name: Phil La Mori

and title...: PhD Executive Vice President

Contact phone: (213) 328-9433 Fax Number: (213) 328-9325

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology name assigned by vendor (e.g., trade name):

Detoxifier (TM)

Technology is being or has been tested in EPA SITE Program ? Yes

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General description of technology:

The Detoxifier TM is a patented, full-scale, transportable treatment unit that uses in situ physical and chemical treatment to remediate contaminated soil. One unique capability of the Detoxifier TM is its flexibility. The Detoxifier TM can: strip VOCs and SVOCs using steam and hot air; and introduce bioactive, oxidative, reductive, and neutralizing agents for a variety of contaminants. The Detoxifier's flexibility allows for the treatment of organics.

The Detoxifier TM consists of a mobile drill tower capable of performing remediation to 30 feet in depth. The drill tower is supported by a mobile process unit and a control unit.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Part 1: General Information and Technology Overview (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology highlights:

The technology advantages are:

* The process provides ACTIVE in situ remediation which is achieved using two hollow drill blades, each 5 feet in diameter and is capable of mixing soil and dispensing steam/hot air or proprietary admixes, chemicals, or solutions.

* The Detoxifier TM is a demonstrated remedial action technology in the U.S. EPA Superfund Innovative Technology Evaluation (SITE) program.

* The Detoxifier TM does not require soil disposal or landfilling during a RCRA corrective action because no soil or debris is removed.

* NOVATERRA has obtained a permit for its transportable treatment unit in California.

* The Detoxifier TM provides steam/hot air remediation with no significant toxic air emissions to adversely impact the nearby residential neighborhood or to violate stringent air quality regulations. This is achieved by treating the contaminated air stream onsite and reinjecting the treated air.

* The technology is currently meeting the applicable California Department of Health Services cleanup standards at a state Superfund site in the Los Angeles basin.

Part 1: General Information and Technology Overview (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- X Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- X Soil
- Sludge
- X Solid
- X Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General sources or types of industrial waste or contaminated sites
that the technology can address:

- | | |
|--|--|
| <input checked="" type="checkbox"/> Agriculture | <input checked="" type="checkbox"/> Paint/ink formulation |
| <input type="checkbox"/> Battery recycling/disposal | <input checked="" type="checkbox"/> Pesticide manufacturing/use |
| <input type="checkbox"/> Chloro-alkali manufacturing | <input checked="" type="checkbox"/> Petroleum refining and reuse |
| <input checked="" type="checkbox"/> Coal gasification | <input checked="" type="checkbox"/> Photographic products |
| <input checked="" type="checkbox"/> Dry cleaners | <input checked="" type="checkbox"/> Plastics manufacturing |
| <input checked="" type="checkbox"/> Electroplating | <input checked="" type="checkbox"/> Pulp and paper industry |
| <input type="checkbox"/> Herbicide manufacturing/use | <input checked="" type="checkbox"/> Other organic chemical manufacturing |
| <input checked="" type="checkbox"/> Industrial landfills | <input checked="" type="checkbox"/> Other inorganic chemical manufacturing |
| <input checked="" type="checkbox"/> Inorganic/organic pigments | <input checked="" type="checkbox"/> Semiconductor manufacturing |
| <input checked="" type="checkbox"/> Machine shops | <input checked="" type="checkbox"/> Rubber manufacturing |
| <input type="checkbox"/> Metal ore mining and smelting | <input checked="" type="checkbox"/> Wood preserving |
| <input type="checkbox"/> Municipal Landfill | <input type="checkbox"/> Uranium mining |
| <input type="checkbox"/> Munitions Manufacturing | |

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology limitations:

- * Subterranean obstructions such as rocks over 12 inches in diameter, steel pipe, and pilings must be removed prior to initiating site remediation using this technology.
 - * Contaminated soil at depths below 30 feet can not be treated using this technology at this time.
 - * Chemical compounds with boiling points greater than 400 degrees F can not be removed using this technology.
 - * The contaminated soil to be treated must be sufficiently compacted to withstand the weight of the equipment without yielding.
 - * This technology cannot remediate contaminated soil under buildings.
 - * Soil compaction may be required after performing remediation using this technology.
 - * Very hard soils may be difficult to treat using this technology.
-

Technology status comments:

The capabilities and experience of the NOVATERRA in situ Detoxifier TM have been demonstrated by the ongoing remediation of a California Superfund site in the Los Angeles area. A private company contracted NOVATERRA (formerly Toxic Treatments) to clean up approximately 16,000 cubic yards (now 40,000 cubic yards) of contaminated soil at its Los Angeles area facility. During initial tests in September of 1988, overall cleanup achieved nearly 96 and 85 percent removals of volatile organic compounds and semivolatile organic compounds, respectively. A U.S. EPA SITE demonstration test was conducted in late 1989 and early 1990. The results of the SITE test showed that "the process removed volatile organic compounds at an average removal efficiency of approximately 85 percent from the contaminated soil tested."

Approximately one-half of the above site has been remediated to date. Post-treatment soil chemical analysis of the 49 chemicals of concern has been performed on 20 percent of the site in both the vadose and saturated zones by the California Department of Health Services. The results, to date, meet or exceed cleanup levels over 98 percent of the time.

**PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data**

Vendor name....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Vendor services:

- Equipment manufacture
X Subcontractor for cleanup services
X Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

The pilot-scale Detoxifier TM simulates the soil mixing, steam and hot air flow characteristics, and other process conditions of the full-scale Detoxifier TM. The pilot system contains a reactor and all necessary support equipment. The pilot system is currently being redesigned from a horizontal to vertical reactor to more closely simulate the full-scale system. The pilot-scale system is supported by an on-line Ratfisch 55CA flame ionization detector and a SRI gas chromatograph. The entire system is contained within a container that can be transported by land or sea.

[illegible]

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Number of pilot-scale systems:

 Planned/in design

 Under construction

 1 Constructed

Pilot-scale facility is:

 X Transportable

 Fixed

 In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

 to 20.00 Kilograms

Can you conduct pilot-scale treatability studies on some type of waste
at your location? Yes

At a contaminated site? Yes

Quantity of waste needed for pilot-scale treatability study:

 60 to 200 Kilograms

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Full-scale Equipment/Capabilities

Major unit processes:

Mobile Drill Tower - The drill tower consists of two hollow overlapping drill blades, each 5 feet in diameter and capable of steam/hot air, and chemical treatment. For the steam/hot air technology, the drill blades inject steam and hot air into the soil, providing the driving force for contaminant stripping. The rise in temperature transforms soil-bound organic contaminants into organic vapors. Contaminant vapors are carried to the soil surface by the steam/hot air flow, emerge from the soil beneath a steel shroud, and are transferred to the process unit for treatment.

The Process Unit - For the steam/hot air technology, the contaminated vapor stream is scrubbed in the process unit to remove particulates. The air stream vapors are then condensed in a multi-stage cooling system. The air-bound contaminants that do not condense are adsorbed onto granulated carbon. After exiting the carbon bed, the airstream is compressed, transferred to the process tower, and re-injected into the ground to treat additional soil.

[illegible]

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Full-scale facility is:

☒ Transportable ☐ Fixed ☐ In situ

Full capacity range per hour:

5.00 to 20.00 Cu yds/hr

Logistical requirements for transportable or in situ technologies:

Space (area).....: 1 ft²

Water: 4 gals. per day

Electrical power: amps

 volts

Natural gas.....: ft³ per day

Sewage access....: ☐ yes ☒ no

"Ballpark" estimate of price range per unit of waste treated:

100.00 to 300.00 per Cubic yard

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Factors that have significant effect on unit price (1 is highest):

<u>1</u>	Initial contaminant concentration	<u> </u>	Excavation
<u>2</u>	Target contaminant concentration	<u> </u>	Waste handling
<u>3</u>	Waste quantity	<u> </u>	Permitting
<u>5</u>	Depth of contamination	<u> </u>	Pretreatment
<u> </u>	Depth to ground water	<u>6</u>	Amount of debris
<u> </u>	Residual quantity	<u>4</u>	Utility/fuel rates
<u> </u>	Residual waste characteristics	<u>4</u>	Labor rates
<u>6</u>	Site preparation		

Others:

2 soil type

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Number of full-scale cleanups initiated or completed by this firm
using this technology:

1

For equipment manufacturers - estimated or actual number of full-scale
cleanups by other firms using this equipment:

Major permits obtained for a full-scale system, and issuing
authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: air emission (for engine)
Issuing Authority.: South Coast AQMD, CA

Permit Type.....: transportable treatment
Issuing Authority.: CA\CA Dept. of Health Serv.

Permit Type.....: fire
Issuing Authority.: local

Permit Type.....: land use
Issuing Authority.: local

Number of full-scale systems:

 Planned/in design

 Under construction

1 Constructed

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types
of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

 2

Description of bench-scale testing procedures:

The bench-scale testing procedures focus on the specific
contaminants targeted for steam/hot air stripping. During
bench-scale tests, physical/chemical mechanisms are explored to
maximize contaminant removal from the soil matrix. The
experimental conditions are varied to determine their effect on
the contaminants of concern.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Halogenated volatiles

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
1.000 to 100000.000	0.000 to 100.000	Full scale

Waste description:

contaminated soil

Soil classification:

clay to sandy

Comments:

treated concentration depends on cleanup criteria

SUMMARY OF PERFORMANCE DATA

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Nonhalogenated volatiles

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
1.000 to 100000.000	ND to 100.000	Full scale

Waste description:

contaminated soil

Soil classification:

clay to sandy

Comments:

treated concentration depends on cleanup criteria

SUMMARY OF PERFORMANCE DATA

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Solvents

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
1.000 to 100000.000	ND to 100.000	Full scale

Waste description:

contaminated soil

Soil classification:

clay to sandy

Comments:

treated concentration depends on cleanup criteria

SUMMARY OF PERFORMANCE DATA

Vendor name.....: NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Halogenated semivolatiles

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
1.000 to 100000.000	ND to 1000.000	Full scale

Waste description:

contaminated soil

Soil classification:

clayey to sandy

Comments:

treated concentration depends on cleanup criteria

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Site name : GATX Annex Terminal Site *

City : San Pedro State: CA

Country : USA

Project type : SUPERFUND/STATE LEAD

Client contact : Dave Wright

Affiliation : GATX

Phone number : (213) 436-0210

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : 1986

Underway : X

Completed/To be completed : 1992

Waste description:

Soil contaminated with VOCs and semivolatiles

AVAILABLE REFERENCES

Vendor name : NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Reference: U.S. EPA SITE Contractor

Source:

Name/Organization: Victor Engleman, SAIC

Address: 10240 Sorrento Valley Road, #204

City : San Diego

State : CA

Zip : 92121

Phone number: (619) 587-9071

AVAILABLE REFERENCES

Vendor name : NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Reference: In Situ Detoxifier

Source:

Name/Organization: Kimberly A. Roy, HAZMAT World

Address: Tower-Borner Publishing, Inc.

City : Glen Ellyn

State : IL

Zip :

Phone number: () -

AVAILABLE REFERENCES

Vendor name : NOVATERRA

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Reference: U.S. Patent Office

Source:

Name/Organization: U.S. Patent Numbers 4,776,409 (10/11/88)

Address: 4,844,807 (07/04/89) 4,844,839 (07/04/89)

City : Washington

State : DC

Zip : _____

Phone number: () - _____

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
VENDOR INFORMATION SYSTEM FOR INNOVATIVE TREATMENT TECHNOLOGIES (VISITT)

Part 1: General Information and Technology Overview

Date submitted: 05/20/91

Developer/Vendor name: UDELL TECHNOLOGIES, INC.

Street address: 4701 Doyle Street, Suite 5

City: Emeryville State: CA Zip: 94608

Country: USA

Contact name: Dr. Lloyd Stewart

and title...: Project Manager

Contact phone: (415) 653-9477

Fax Number: (415) 653-9479

Telex number: () -

Standard technology type:

SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology name assigned by vendor (e.g., trade name):

Technology is being or has been tested in EPA SITE Program ? Yes

Literature on technology available on request ? Yes

Part 1: General Information and Technology Overview (continued)

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General description of technology:

The in situ steam injection vacuum extraction process is designed to remove volatile and semivolatile organic compounds from an area of contaminated soil without need for excavation. The process operates through use of wells constructed in the contaminated soil. High quality steam is added to the soil through some wells, called injection wells. Other wells, known as extraction wells, are operated under vacuum to remove liquid and vapor contaminants and water from the soil. The injection of steam into the ground raises the temperature of the soil and causes the most volatile compounds to vaporize. A pressure gradient is formed between the injection and extraction wells, and this drives the flow of steam and vaporized contaminants towards the extraction wells. Raising the temperature of the soil matrix also assists in the removal of less volatile compounds by increasing their in situ vapor pressure.

After the entire soil mass under treatment has reached the steam temperature, as determined by soil-temperature monitors, and steam breakthrough occurs at the extraction wells, the flow of steam continues only intermittently with a constant vacuum applied to the extraction wells. The vacuum extraction removes much of the remaining contamination. As the soil in the high permeability region cools, the steam remaining in the low permeability region evaporates the contaminants.

Part 1: General Information and Technology Overview (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology highlights:

*The process operates on contaminated soil in situ, so little contaminated material needs to be excavated, stored, or disposed.

*The addition of steam enables the process to remove semivolatile compounds, and is more efficient, rapid, and complete than treatment with vacuum extraction alone.

*The volatile compounds are removed from the soil in concentrated form. This reduces the amount of waste requiring treatment or disposal, and facilitates recycling of many compounds.

*The process will also remove contamination from groundwater, if any is present in the treatment area.

*Once the wells are drilled and the system installed, treatment is not labor-intensive. The system has few mechanical parts which would require service during treatment.

*The process is most cost-effective for large and deep areas of contamination where technologies requiring excavation would be difficult or impossible. The process can be applied in sections to treat an area of any size.

[illegible]

Part 1: General Information and Technology Overview (continued)

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology status:

- Bench scale or emerging. Technology shown to be feasible through the use of bench-top equipment in the laboratory. Available data cannot be used to scale up to full scale in the absence of additional pilot-scale or full-scale experience for similar applications.
- Pilot scale. Available equipment is of sufficient size to verify technology feasibility or establish the design and operating conditions for a full-scale system. However, it is not of the size typically used for a cleanup.
- ☒ Full scale. Available equipment is sized and commercially available for actual site remediation.

Potential or actual waste/media treated:

- ☒ Soil
- ☒ Sludge
- Solid
- Natural sediment
- Ground water in situ

Part 1: General Information and Technology Overview (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Potential or actual contaminants and contaminant groups treated by this technology:

<u>Organic</u>	<u>Inorganic</u>
<input checked="" type="checkbox"/> Halogenated volatiles	<input type="checkbox"/> Heavy metals
<input checked="" type="checkbox"/> Halogenated semivolatiles	<input type="checkbox"/> Nonmetallic toxic elements
<input checked="" type="checkbox"/> Nonhalogenated volatiles	<input type="checkbox"/> Radioactive metals
<input checked="" type="checkbox"/> Nonhalogenated semivolatiles	<input type="checkbox"/> Asbestos
<input type="checkbox"/> Organic pesticides/herbicides	<input type="checkbox"/> Inorganic cyanides
<input type="checkbox"/> Dioxins/furans	<input type="checkbox"/> Inorganic corrosives
<input checked="" type="checkbox"/> PCBs	
<input checked="" type="checkbox"/> Polynuclear aromatics (PNAs)	<u>Miscellaneous</u>
<input checked="" type="checkbox"/> Solvents	<input type="checkbox"/> Explosives/propellents
<input checked="" type="checkbox"/> Benzene-toluene-ethylbenzene-xylene (BTEX)	<input type="checkbox"/> Organometallic pesticides/herbicides
<input type="checkbox"/> Organic cyanide	
<input type="checkbox"/> Organic corrosives	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

General sources or types of industrial waste or contaminated sites that the technology can address:

<input type="checkbox"/> Agriculture	<input checked="" type="checkbox"/> Paint/ink formulation
<input type="checkbox"/> Battery recycling/disposal	<input type="checkbox"/> Pesticide manufacturing/use
<input type="checkbox"/> Chloro-alkali manufacturing	<input checked="" type="checkbox"/> Petroleum refining and reuse
<input checked="" type="checkbox"/> Coal gasification	<input type="checkbox"/> Photographic products
<input checked="" type="checkbox"/> Dry cleaners	<input type="checkbox"/> Plastics manufacturing
<input type="checkbox"/> Electroplating	<input checked="" type="checkbox"/> Pulp and paper industry
<input type="checkbox"/> Herbicide manufacturing/use	<input type="checkbox"/> Other organic chemical manufacturing
<input checked="" type="checkbox"/> Industrial landfills	<input type="checkbox"/> Other inorganic chemical manufacturing
<input type="checkbox"/> Inorganic/organic pigments	<input checked="" type="checkbox"/> Semiconductor manufacturing
<input checked="" type="checkbox"/> Machine shops	<input type="checkbox"/> Rubber manufacturing
<input type="checkbox"/> Metal ore mining and smelting	<input checked="" type="checkbox"/> Wood preserving
<input checked="" type="checkbox"/> Municipal Landfill	<input type="checkbox"/> Uranium mining
<input type="checkbox"/> Munitions Manufacturing	

Others:

Part 1: General Information and Technology Overview (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Technology limitations:

*The technology requires a site to have a barrier layer below the depth of contamination. Dependent upon the type of contamination, this layer can be either a high permeability layer, a low permeability layer or the water table.

*The high permeability barrier works with low boiling point contaminants. A low permeability barrier works with a dense nonaqueous phase liquid, and the water table works with contaminants that are lighter than water.

*If the site contains a high concentration (>200ppm) of heavier-than-water organics, there is a possibility that these compounds might be mobilized downward into groundwater.

*Treatment of shallow (<10 feet) contaminated areas is less cost effective than deeper areas in comparison to competing technologies.

Technology status comments:

In August of 1988 a successful pilot-scale demonstration of the process was completed. The site was contaminated by a mixture of solvents and 764 pounds of contaminant were removed from the 10-foot diameter, 12-foot deep test region. Three full scale demonstrations of the process are in the design phase. One is a system to remediate a gasoline spill both above and below the water table to depths of 120 feet. A second addresses free product jet fuel floating on top of groundwater at a depth of approximately 16 feet. The third demonstration will treat a burn pit and soil contaminated with solvents down to a depth of approximately 90 feet.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Vendor services:

- ☐ Equipment manufacture
- ☒ Subcontractor for cleanup services
- ☒ Prime contractor for full-service remediation

Pilot-scale Equipment/Capabilities

Major unit processes:

The skid-mounted steam generator contains a boiler, water conditioner, and makeup tank, and is supplied with fuel. The piping that connects the steam generator to the injection wells contains liquid traps to assure high quality steam, and regulators to control the flow. The wells (injection and extraction) are drilled to below the depth of contamination on the site. A negative pressure is maintained on the extraction wells by a high-volume vacuum pump. A liquid pump is used to remove condensed organics and water from the wells. The extracted vapors are treated in a condenser and knock-out drum. Gases remaining are treated in a carbon adsorption system, while the condensed liquids are added to the liquids from the extraction wells in a settling tank. An oil/water separator removes the concentrated organics for recycling or disposal. The remaining contaminated water requires treatment or it can be discharged to an industrial treatment facility.

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Number of pilot-scale systems:

3 Planned/in design

 Under construction

1 Constructed

Pilot-scale facility is:

X Transportable

- Fixed

- In situ

Pilot capacity range per hour. Capacity of batch processes is prorated.

 to

Can you conduct pilot-scale treatability studies on some type of waste
at your location? No

At a contaminated site? Yes

Quantity of waste needed for pilot-scale treatability study:

500 to Cubic yard

Number of pilot-scale studies conducted on wastes from different sources
or sites. Does not include tests on surrogate wastes.

Detailed Information and Performance Data (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Full-scale Equipment/Capabilities

Major unit processes:

The skid-mounted steam generator contains a boiler, water conditioner, and makeup tank, and is supplied with fuel. The piping that connects the steam generator to the injection wells contains liquid traps to assure high quality steam, and regulators to control the flow. The wells (injection and extraction) are drilled to below the depth of contamination on the site. A negative pressure is maintained on the extraction wells by a high-volume vacuum pump. A liquid pump is used to remove condensed organics and water from the wells. The extracted vapors are treated in a condenser and knock-out drum. Gases remaining are treated in a carbon adsorption system, while the condensed liquids are added to the liquids from the extraction wells in a settling tank. An oil/water separator removes the concentrated organics for recycling or disposal. The remaining contaminated water requires treatment or it can be discharged to an industrial treatment facility.

[illegible]

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Full-scale facility is:

☒ Transportable ☐ Fixed ☐ In situ

Full capacity range per hour:

_____ to _____

Logistical requirements for transportable or in situ technologies:

Space (area)....: _____ ft²

Water: _____ gals. per day

Electrical power: _____ amps

_____ volts

Natural gas.....: _____ ft³ per day

Sewage access...: ☐ yes ☐ no

"Ballpark" estimate of price range per unit of waste treated:

50.00 to 125.00 per Cubic yard

Price estimates shown above do not always include all indirect costs associated with treatment, such as: excavation, permits and treatment of residuals. For price comparisons, users should make certain that vendors provide estimates based on comparable remediation activities.

Detailed Information and Performance Data (continued)

Vendor name....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Factors that have significant effect on unit price (1 is highest):

<u>13</u>	Initial contaminant concentration	<u>14</u>	Excavation
<u>6</u>	Target contaminant concentration	<u>7</u>	Waste handling
<u>5</u>	Waste quantity	<u>15</u>	Permitting
<u>2</u>	Depth of contamination	<u>16</u>	Pretreatment
<u>10</u>	Depth to ground water	<u>17</u>	Amount of debris
<u>11</u>	Residual quantity	<u>8</u>	Utility/fuel rates
<u>12</u>	Residual waste characteristics	<u>9</u>	Labor rates
<u>3</u>	Site preparation		

Others:

```
1 areal extent
4 surface activities
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PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Number of full-scale cleanups initiated or completed by this firm
using this technology:

For equipment manufacturers - estimated or actual number of full-scale
cleanups by other firms using this equipment:

Major permits obtained for a full-scale system, and issuing
authority (e.g., RCRA, TSCA, NPDES, and Clean Air Act).

Permit Type.....: NA No full-scale systems
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Permit Type.....: _____
Issuing Authority.: _____

Number of full-scale systems:

 3 Planned/in design

 Under construction

 2 Constructed

PART 2: Pilot- and Full-scale Technologies:
Detailed Information and Performance Data (continued)

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Treatability Study Capabilities (Bench Scale)

Can you conduct bench-scale treatability studies on some types
of waste at your location: X yes _ no

Number of bench-scale studies conducted to date.
Does not include tests on surrogate wastes:

7

Description of bench-scale testing procedures:

Soil samples are collected in the field using a hollow stem
auger in either 2.0 or 2.5-in diameter brass sleeves.
Undisturbed, the brass sleeve is uncapped and pushed into a
modified 2.0 or 2.5-in diameter, 6.0-in long, schedule 40
stainless steel tube. The ends are capped and the entire holder
is covered with insulation. Steam is injected at a constant rate
at one end of the holder. After some period, condensate appears
at the exit and is collected. Later, steam breaks through and is
passed to a condenser before collection. The soil is analyzed
for the contaminant concentrations before and after the test, and
the collected liquid is also tested.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Solvents

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
2065.000 to 2065.000	12.000 to 12.000	Pilot scale

Waste description:

Mixture of acetone, 2-butanone, TCA, TCE and BTEX

Soil classification:

sand

Comments:

Treated/untreated concentrations are for two soil samples recovered from the same depth, separated by 2 feet. Concentrations presented are average concentrations.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Gasoline

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
3000.000 to 3000.000	2.000 to 2.000	Bench scale

Waste description:

gasoline

Soil classification:

sand

Comments:

Concentrations presented are average concentrations.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Diesel

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
1500.000 to 1500.000	19.000 to 19.000	Bench scale

Waste description:

diesel

Soil classification:

silty clay with gravel

Comments:

Concentrations presented are average concentrations.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Petroleum Hydrocarbons - Total, Gasoline

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
4200.000 to 4200.000	220.000 to 220.000	Bench scale

Waste description:

ash from burn pit containing solvents and hydrocarbons

Soil classification:

ash

Comments:

Concentrations presented are average concentrations.

SUMMARY OF PERFORMANCE DATA

Vendor name.....: UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Contaminant, contaminant group, or pollutant parameter:

Jet fuel JP-5

Untreated concentration range Mg/kg	Treated concentration range Mg/kg	Equipment Scale
49000.000 to 49000.000	59.000 to 59.000	Bench scale

Waste description:

similar to kerosene

Soil classification:

sand

Comments:

Concentrations presented are average concentrations.

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Site name : Solvent Service, Inc.

City : San Jose State: CA

Country : USA

Project type : PRIVATE

Client contact : Amit Nagpal

Affiliation : President

Phone number : (408) 259-9910

Equipment Scale:

- ☐ Bench scale
- ☒ Pilot scale
- ☐ Full scale

Project status (Month/Year):

Contracted : _____

Underway : _____

Completed/To be completed : 08/88

Waste description:

Solvent recycling facility; mixture of 13 solvents in soil
(35 cubic yards)

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Site name : Municipal Waste Hauler

City : Huntington Beach State: CA

Country : USA

Project type : PRIVATE

Client contact : Jay Dablow

Affiliation : Hydro-Fluent, Inc.

Phone number : (714) 966-1446

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : _____

Underway : ☒ _____

Completed/To be completed : _____

Waste description:

135,000 gallons of diesel leaked into soil from underground
pipeline rupture.

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Site name : McClellan Air Force Base *

City : Sacramento State: CA

Country : USA

Project type : SUPERFUND/DOD LEAD

Client contact : Capt. Fran Slavich

Affiliation : McClellan AFB

Phone number : (916) 643-1250

Equipment Scale:

☐ Bench scale

☐ Pilot scale

☒ Full scale

Project status (Month/Year):

Contracted : 05/91

Underway : X

Completed/To be completed :

Waste description:

Burn and disposal pit and underlying soil - 20,000 cub yd

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Site name : Lemoore Naval Air Station

City : Lemoore State: CA

Country : USA

Project type : DOD LEAD

Client contact : Dr. Deh Bin Chan

Affiliation : Naval Civil Engineering Laboratory

Phone number : (805) 982-4191

Equipment Scale:

- ☐ Bench scale
- ☒ Pilot scale
- ☐ Full scale

Project status (Month/Year):

Contracted : 05/91
Underway : X
Completed/To be completed :

Waste description:

Jet fuel (JP-5) contaminated soil (2,000 cubic yards)

REPRESENTATIVE CLEANUP PROJECTS

Vendor name : UDELL TECHNOLOGIES, INC.

Technology type: SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

Site name : Lawrence Livermore National Laboratory

City : Livermore State: CA

Country : USA

Project type : DOE LEAD

Client contact : Roger Aines

Affiliation : LLNL

Phone number : (415) 423-7184

Equipment Scale:

- ☐ Bench scale
- ☐ Pilot scale
- ☒ Full scale

Project status (Month/Year):

Contracted : NA

Underway : X

Completed/To be completed :

Waste description:

Gasoline contaminated soil
